

**Methyl Bromide Alternatives  
Toronto Trials  
June 6–10, 1999**

Roger Cavašin<sup>1\*</sup>, David K. Mueller<sup>2</sup>, Alain Van Ryckeghem<sup>3</sup>, Michel Maheu<sup>4</sup>, Martin Saint-Pierre<sup>4</sup>

**Purpose:**

Methyl bromide fumigant is presently the only pesticide recommended for the disinfestation of empty ship holds in Canada. Between 6-30 empty commodity ships are fumigated in Canada each year. Trials to determine the alternatives to methyl bromide in ship holds were planned using two formulations of phosphine and one method of capturing and recovering methyl bromide from a ship hold. During these trials, separate studies on phosphine corrosion and boundary line air sampling were conducted.

**Introduction**

ECO<sub>2</sub>FUME™ is a gaseous phosphine formulation that comes in a cylinder rather than a pellet, tablet or granular form. This gaseous mixture contains 2% phosphine by weight (2.6% by volume). There is one pound of phosphine per steel cylinder. Each cylinder of ECO<sub>2</sub>FUME will treat 21,600 cu.ft./ (650 cu.m.). at 500 ppm. The advantages of ECO<sub>2</sub>FUME ease of application, speed of application, safe application, no disposal of residual undecomposed fumigant, non-ozone depletor, and ability to redose accurately. The disadvantages of ECO<sub>2</sub>FUME are: 10 cylinders of fumigant instead of 4 cylinders of methyl bromide were needed. The time it takes to kill all stages insect life can be greater than methyl bromide. Phosphine can cause corrosion on copper and brass.

**Sealing**

A minimum amount of sealing is necessary to for a ship hold. The hatch covers are secured and taped with 2-inch wide metal (furnace) tape. The four drain holes in the bottom of the hold (24" x 18") are covered with 6 mil polyethylene, glued, and taped. The manhole (31") is sealed with 4-mil polyethylene. For this test, adjacent drain holes were also covered and sealed. All procedures followed confined space and climbing protection procedures.

**Pressure Testing**

Pressure tests were performed on each hold. A high-pressure (1/2 hp) blower was used to form a positive pressure in the hold of 1.5 inches of pressure. This was recorded on a Magnehelic pressure gauge. The half-life of the pressure degradation was timed and recorded (1.5 to .75 inches). The half-life of the pressure in hold #4 (ECO<sub>2</sub>FUME) was 13 minutes and 30 seconds. This is considered a tight and secure enclosure by fumigation standards.

### **Insect Bio-Assays**

Mixed stages of various stored product insects were placed in each hold and in a control hold. Additional insect bioassays were placed in hold #4 to be pulled from the fumigated hold at different times than the standard test on all three holds. Five insect bioassays containing 10 adult and mixed stages of Red flour beetles (*Tribolium castaneum*) were pulled after 12 hours under fumigation. No adults or larvae were mobile from the 12-hour exposure at 500 ppm. The immature insects were placed in an insect growth chamber at 28 C, 14/7 photoperiod, and 58% relative humidity. After 30 days, no insect activity was observed.

### **Corrosion Test**

A Zenith computer (512 K) and monitor were placed in the fumigated hold to check the period of time it would take to cause the computer to cease functioning because of phosphine corrosion. Every two hours the computer was checked by carrying out a set function in word processing on an external keyboard. A fatal error appeared on this monitor after 25.5 hours at 500 ppm. The computer has been sent to Dr. Bob Brigham at Can-Met in Ottawa for further evaluation.

Copper strips were carefully prepared and placed in the hold. Samples were removed periodically for evaluation of weight gain and weight loss by Dr. Brigham.

### **Application**

A rate of 500 ppm of ECO<sub>2</sub>FUME was determined for hold #4 on the bulk carrier Canadian Trader. The hold was estimated to be 190,000 cu.ft./ 6,000 cu.m. The ECO<sub>2</sub>FUME was manifolded with stainless steel fittings. Since these fittings are under high pressure (800 PSI), care was taken to pressure test each fitting with a soap bubble solution and nitrogen pressure to check for leaks. At 12:30 PM on Sunday June 6, 1999 the first four ECO<sub>2</sub>FUME cylinders were released in about 15 minutes. Individual cylinders of ECO<sub>2</sub>FUME were dispensed until the concentration of phosphine reached 500 ppm. The total time to dispense the nine cylinders was about 2 hours. This slow release was needed to not fill up the hold with too much pressure at one time. Each cylinder takes approximately four minutes to dispense.

Rigid copper tubing was connected to the cylinder nozzles and placed approximately 40 feet away into the manhole cover. No freezing of lines or interruption of phosphine dispensing due to line freezing occurred.

### **Environmental Readings**

Fumigant readings were taken every 2 hours after ECO<sub>2</sub>FUME was discharged for the first 24 hours and every 4 hours thereafter. Polyethylene lines (5/16") were placed at the top of the hold (10'), middle (20'), and the bottom (40'). Readings included relative humidity, carbon dioxide, and phosphine. Temperature readings were taken visually through the plastic cover on the manhole and with data loggers.

### **Boundary Line Air Sampling**

To insure safety of fumigants from non-applicators working next door to the vessel, air sampling was conducted every six hours near the open doors of the recycling warehouse. This was located 35 feet from the vessel and approximately 70 feet from the nearest ship hold opening. Sampling was performed with the Draeger PAC III. The sensitivity of this new phosphine sampling device was 0.01 ppm.

The results of the boundary line air sampling showed no detectable levels of phosphine fumigant at any time during the three-day study.

### **Special Comments:**

A rare condition was experienced during these trials. The cooling of the ship hold each evening caused a negative pressure in each hold. The pressure was recorded by the Magnehelic gauge to be 2.5 inches of pressure at one point. This is a tremendous amount of pressure on the seals. The opposite effect occurred when the sun would begin heating the vessel in the morning. The fumigant and gases in the hold would expand and cause a positive pressure to be created. Gas readings were difficult to record during the evening hours because of the negative pressure being exerted on the sampling lines.

This experiment showed the ease of application and high safety level of a new fumigant. ECO<sub>2</sub>FUME performed well in this ship hold trial. The various visiting fumigators and government agencies could view this new fumigant and discuss other potential applications. ECO<sub>2</sub>FUME is not registered in Canada at this time and registration with the US EPA is pending.

1 Roger Cavisin, Cytex Canada, Inc., P.O. Box 240, Niagara Falls, Ontario, L2E6T4 Canada

2 David Mueller, Fumigation Service & Supply, Inc., 16950 Westfield Park Rd., Westfield, IN 46074 USA

3 Alain Van Ryckeghem, Insects Limited, Inc., 16950 Westfield Park Rd., Westfield, IN 46074 USA

4 Michel Maheu, Maheu-Maheu, Inc., 710 Bouvier, Suite 195, Quebec G2J1C2, Canada

5 Martin Saint-Pierre, Maheu-Maheu, Inc., 710 Bouvier, Suite 195, Quebec G2J1C2, Canada